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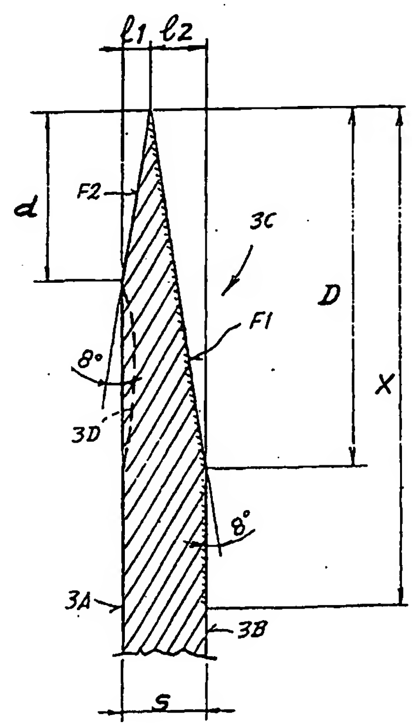
(57) Abstract

The cutting tool (3) comprises a continuous circumferential cutting edge (3c) formed by a chamfer defined by two asymmetrical sides (F1, F2), one (F1) having a greater extension and the other (F2) having a smaller extension, the side with the greater extension (F1) being surface hardened.



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DISK-SHAPED CUTTING TOOL, METHOD OF SHARPENING IT AND CUTTING MACHINE USING SAID TOOL

DESCRIPTION

Technical field

The present invention relates to a rotating disk-shaped cutting tool, of the type having a continuous circular cutting edge, in other words one which is not serrated.

The invention also relates to a method of sharpening a tool of the aforesaid type.

The invention additionally relates to a cutting machine using a tool of the aforesaid type, typically a cutting machine for cutting rolls of wound-up web material, for example paper, tissue paper, non-woven textile, or other sheet material.

Prior art

Cutting machines having the function of cutting rolls of wound-up web material into small rolls having smaller axial dimensions are used in the paper converting industry. The rolls or logs having a large axial measurement, obtained from a rewinding machine, are fed, with continuous or intermittent motion, to the cutting machine which divides them into small rolls having an extension equal to the final dimension of the product, for example toilet paper, paper towels or similar.

An example of a cutting machine of this type is described, for example, in US-A-5,315,907.

The cutting machine is provided with one or more disk-shaped blades or tools rotating at high speed about their own axes and cyclically caused to penetrate into the material to be cut. At the present time, the tool or tools used for these purposes have a biconical shape. In other words, they have a greater thickness in the proximity of the axis, which gradually decreases from the axis toward the edge. The cutting edge is formed by a chamfer which is symmetrical about the median plane orthogonal to the axis of the tool.

The tool requires frequent sharpening to restore the cutting edge, particularly when steel of limited hardness, such as high-speed steel, is used

for its construction. For this purpose use is made of pairs of grinding wheels, motorized or more frequently driven by the same motive power as the tool, which act in a more or less symmetrical way on the two sides of the chamfer. The diameter of the tool is thus gradually reduced from the original dimension to a minimum diametric dimension, below which the tool must be replaced. The wear and damage to the cutting edge are rather rapid, and this necessitates frequent sharpening and consequently a relatively rapid diametric loss. Hence it is necessary to use large initial diameters, in order to reduce the number of replacements required, and especially to write off the cost of the individual tool over a sufficient quantity of cut product.

The size of the product to be cut and of the support hub of the tool are such that it is impossible to reduce the diametric dimension below a minimum level.

The biconical shape of the tool causes the generation of large amounts of friction between the tool and the material to be cut. Moreover, a large quantity of initial material is required for forging a tool of biconical shape.

<u>Objects of the invention</u>

The object of the present invention is to provide a disk-shaped cutting tool with a continuous edge which overcomes the disadvantages of conventional tools, and to provide a cutting machine and a method of sharpening which overcome the limits of conventional machines and methods.

In general, one object of the present invention is to provide a tool which makes it possible to simplify the sharpening unit and reduce its cost, while also increasing its reliability.

A further object of the present invention is to provide a tool and a method of sharpening which makes it possible to reduce the sharpening operations and to limit the wear on the tool.

Another object of the present invention is to provide a tool which is more efficient and more suitable for use in cutting rolls of web material, particularly rolls of paper, tissue paper, non-woven textiles and other sheet material.

A further object of the present invention is to provide a tool which has a

lower cost, lower mass and smaller dimensions.

Yet another object of the invention is to provide a tool which is more easily sharpened.

The invention also has the object of providing a cutting machine which is more efficient than conventional machines.

Brief description of the invention

These and other objects and advantages, which the following text will make clear to those skilled in the art, are achieved essentially with a disk-shaped cutting tool comprising a continuous circumferential cutting edge, in other words one which is not serrated, characterized in that said cutting edge is formed by a chamfer defined by two asymmetrical sides, one having a greater extension and the other having a smaller extension, the side with the greater extension being surface hardened. It should be understood that the sizes of the two chamfers (one greater than the other) relate to the new tool, in other words before the initial sharpening. The subsequent use and subsequent wear and sharpening cause, as explained below, the reduction of the chamfer which originally had a greater extension until it becomes smaller than the other.

This tool can be sharpened with a single grinding wheel acting on the smaller side (in other words on the side which has the smaller extension when the tool is new). It was found that a tool of this type had a much smaller wear of the cutting edge, with a reduction of at least thirty times in the number of sharpening operations and a consequently much longer life of the tool.

Many advantages are derived from this. In the first place, there is a lower cost, due to the lower consumption of tools. Moreover, the initial diameter of the tool can be smaller than the diameters conventionally used for the disk-shaped cutting blades used in cutting machines. The tool according to the invention may have an initial external diameter (in other words, before the initial sharpening) of 510 to 530 mm, as against the diameter of 610 mm normally used for these purposes.

The use of a tool having a smaller diameter has further advantages. The mass of the tool is reduced and consequently its inertial forces are also

reduced. This is particularly important when the tool is located on a plate which is provided with a non-continuous drive. There are cutting machines in which the cutting tool is mounted with its axis on an oscillating plate which is therefore subject to angular acceleration about the axis of oscillation. In this case, a lower mass of the blade reduces the dynamic stresses. In other cases, in US-A-5,315,907 for example, the blade is mounted on a plate provided with a reciprocating rectilinear motion along the direction of advance of the rolls to be cut. In this case also, the reduction of the mass of the blade causes a reduction of the inertial forces in play.

Additionally, a cutting tool of smaller diameter remains engaged in the cutting material for a shorter time. Consequently it is possible to make cutting machines with faster production speeds, since the speed of advance of the rolls can be increased.

The lower frequency of the sharpening operations has the further advantage of reducing the risks of fire arising from the generation of sparks during sharpening. In environments in which cutting machines have to operate, there is a high risk of fire owing to the presence of paper dust, frequently impregnated with lubricating oil. The considerable reduction of the number of sharpening operations reduces the percentage fire risk to a corresponding degree.

The two sides may form a chamfer with an included angle of approximately 15-30° and the angle which each side forms with a plane orthogonal to the axis of rotation of the tool may vary, for example, from 0 to 15° and in particular from 0 to 10°. This means that one of the two sides (typically the side having the greater extension) may be located on the plane orthogonal to the axis of rotation of the tool, while the other side is inclined.

The inclinations of the two sides of the cutting tool may be different from each other, but in a preferred embodiment the two sides have the same inclination, preferably in the range from 6° to 9° with respect to a plane orthogonal to the axis of rotation of the tool, and preferably equal to approximately 8°. More generally, the difference between the angles which the two sides form with a plane orthogonal to the axis of rotation of the tool is,

for example, in the range from 0 to 10°, but is preferably small and normally in the range from 0 to 3°.

The tool may have a biconical shape, but in a particularly advantageous embodiment of the invention it has a cylindrical extension, in other words is delimited by two parallel flat surfaces spaced apart by an amount equal to the axial thickness of the tool which, in this case, is constant over the whole of its radial extension. In this way it is possible to provide a tool which has an even lower weight and an edge thickness which does not vary during use as a result of sharpening, as happens in conventional tools. The absence of a conical frontal surface, in other words one inclined with respect to the median plane of the tool, considerably reduces the forces which the material to be cut and the tool exchange during cutting, and consequently reduces the forces on the tool and on the supports of its shaft, and improves the quality of the cut. This makes it possible to provide a tool of limited thickness, typically in the range from 2 to 4 mm and preferably from 2.5 to 3.5 mm and more particularly from 2.8 to 3 mm. In this way a tool having very low weight and cost is obtained, the construction of which is considerably more economical than that of a conventional tool of biconical shape.

Additionally, since the edge thickness of the tool does not change with a decrease in the diameter caused by the sharpening, when the whole hardened side of the tool has been used up and therefore the tool can no longer be used in the cutting machine, the tool can still be recycled for other uses, for which smaller diameters are sufficient.

The tool of cylindrical shape and reduced diameter has a mass of less than half that of conventional tools of biconical shape, for the same operating specifications. For example, a tool for use in a tissue paper roll cutter has, on average, a mass of approximately 4 kg, while a tool for the same use made according to the invention has a mass of 1.8-1.9 kg. This yields considerable advantages in terms of reduction of inertia. The cost of the tool is also lower, since the amount of initial material required to produce each tool is smaller than that normally used for conventional tools. The reduction in terms of quantity of material is such that it also compensates for the greater cost per

unit weight of the material used.

The asymmetrical sides of the cutting edge form a chamfer which, when the blade is new, is not located on the median plane of the tool, but is displaced toward the face on which the non-hardened side is formed. Typically, the chamfer is located (when the tool is new) in a position along the axial extension of the tool such that the tool is divided into a larger part, in the range from 2/3 to 3/4 of the overall thickness of the tool, and a smaller part, in the range from 1/3 to 1/4 of said thickness.

The tool is advantageously made, for example, from super-high-speed steel or steel sintered from powder, to produce a very fine crystal grain structure, making it possible to obtain a high degree of finish and a good adhesion of the hardening facings. The hardening can be carried out by deposition of one or more layers of nitrides, for example nitrides of titanium, chromium, aluminum or equivalent, and/or by deposition of chromium. In the case of stratified hardening, the layers may be of the same material or of different materials.

The tool according to the invention is particularly suitable for cutting rolls of wound-up web material, particularly paper, tissue paper, non-woven textiles and other items. However, it may also be advantageously applied in cutting other types of material, for example in the continuous cutting of web material, such as sheets of cardboard, corrugated cardboard and similar materials, and plastic, and in cutting hides, cloth and other items.

The present invention also relates to a cutting machine for rolls of wound-up web material, comprising one or more tools of the type described above.

Since it is sufficient to sharpen only the non-hardened side, the cutting machine may have a single grinding wheel or group of grinding wheels for sharpening, arranged in such a way as to act on said side, which will typically be that opposite the side where the material to be cut arrives.

Further advantageous characteristics of the tool and of the cutting machine according to the invention are described below and are indicated in the attached claims.

Brief description of the drawings

The invention will be more clearly understood from the description and the attached drawing, which shows a non-restrictive practical example of the invention. In the drawing,

Fig. 1 shows the front part of a cutting machine;

Fig. 2 shows an axial section through the tool in one embodiment;

Fig. 3 shows a partial front view according to III-III in Fig. 2;

Figs. 4A-4C show the area of the chamfer of the tool at successive stages of use; and

Fig. 5 shows an enlargement of the area of the chamfer to a large scale.

Detailed description of an embodiment of the invention

Fig. 1 shows an example of a cutting machine equipped with a tool according to the present invention. As will be made clear by the following text, the specific characteristics of the cutting machine are not essential, and the advantages of the tool according to the invention can also be obtained with different configurations of the cutting machine.

In the example shown in Fig. 1, the cutting machine, indicated as a whole by the number 1, has one or more channels C parallel to each other for the advance of the rolls or logs L. The logs are cut into small rolls R by a disk-shaped cutting tool 3 rotating about its axis B-B. The axis B-B is supported by a plate 5, rotating about an axis A-A which, in this particular example, is parallel to the axis B-B and parallel to the direction of advance F of the logs L. The rotation of the plate 5 about the axis A-A causes the tool 3 to become engaged cyclically in the material of the logs L to be cut. The number 7 indicates a motor which, by means of a transmission belt 8, rotates the plate 5 about the axis A-A, while the number 9 indicates a motor which rotates the tool 3.

The logs L are made to advance along the channels C by pushers 11 fixed to chains or belts 13 driven by a motor 15. The motors 7 and 15 are synchronized with each other by a control unit 19. The advance of the logs L takes place with a continuous motion, but preferably with a variable speed, in

other words a lower speed at the stage at which the tool 3 is engaged in the material to be cut and a higher speed when the tool is not engaged in the material. The plate 5 is correspondingly provided with a rectilinear reciprocating motion in the direction of the double arrow f5 to enable the tool 3 to advance at the speed of the logs L during cutting.

The machine described up to this point essentially corresponds to that described in US-A-5,315,907, to which reference should be made for further details.

The tool 3 is illustrated in detail in Figs. 2, 3 and 5. It has a circular shape and is delimited by two flat parallel surfaces, front and rear, indicated by 3A and 3B in Fig. 2. The thickness of the tool 3 is therefore uniform - except along the circumferential edge where the chamfer described below is formed - and is typically in the range from 2 to 4 mm and preferably in the range from 2.8 to 3 mm.

Along its edge, the tool 3 has a chamfer 3C formed by two asymmetrical sides F1 and F2, shown in greater detail in Fig. 5. The inclinations of the two sides with respect to a plane orthogonal to the axis of rotation (indicated by A-A) are equal: in axial section, both form an angle of approximately 8° with the front surface of the tool (see Fig. 5), and therefore with a plane orthogonal to the axis of rotation B-B. However, the side F1 has a greater extension in the radial direction of the tool and covers a circular rim portion of width D in the radial direction, while the side F2 covers a radial strip having the size d. The circular cutting edge formed by the intersection between the two truncated conical surfaces of the sides F1 and F2 is located at a distance l1 from the surface 3A and at a distance l2 from the surface 3B of the tool. The length l1 is equal, in the illustrated example, to approximately 1/3 of the total thickness S of the tool, while the length l2 is equal to the remaining 2/3. The position of the cutting edge can also be displaced further toward the surface 3A, for example with l1=S/4.

The surface forming the side F1 is hardened, as shown schematically by the shading in Figs. 2 and 5, by lamination with titanium nitride or other equivalent material. In the illustrated example, the hardening covers a strip in

the form of a circular rim having a radial extension of X, which is greater than the radial extension D of the side F1 (Fig. 5), and is, for example, 25 mm.

When the tool is mounted on the machine 1, the hardened side F1 of the tool is on the side where the logs L arrive. In this way the hardened surface of the tool is that which is most subject to the pressing force generated by the material during cutting.

The chamfer 3C is sharpened by a single grinding wheel 21 which acts on the side F2, in other words on the non-hardened side, of the chamfer 3C. The grinding wheel 21 is positioned as shown in Fig. 1, in other words on the opposite side of the tool 3 to the side where the logs arrive, and can be, if necessary, a grinding wheel which is motorized, by means of a pneumatic motor, for example, or in another suitable way which a person skilled in the art may select according to his knowledge. The use of a motorized grinding wheel instead of an idle wheel caused to rotate by friction with the tool, is advisable, since the pressure between the grinding wheel and tool is preferably very small, while the grinding wheel is made with very hard, and therefore highly abrasive, particles, and with a relatively soft filler. The motorizing of the grinding wheel ensures that the wheel is always rotating when it touches the tool, even at a low angular velocity, thus preventing the formation of steps on the active surface of the grinding wheel.

In the present case, as in conventional machines, the grinding wheel 21 is placed on a slider 23 carried by the plate 5 and periodically brought closer to the axis B-B of the tool 3 to compensate for the wear of the tool. An actuator can be used, in a known way, to periodically bring the grinding wheel 21 into contact with the side F2 of the chamfer 3C.

Fig. 4 shows three separate stages of wear of the tool 3 during use, as well as the relative positions of the tool and the grinding wheel 20. In Fig. 4A the tool is new, and the chamfer 3C is intact and has the shape shown also in greater detail in the enlargement in Fig. 5.

Fig. 4B shows an intermediate stage of wear of the tool, in which the cutting edge is approximately at the midpoint of the thickness of the tool 3. In Fig. 4C, the tool is almost completely worn, and the cutting edge is closer to

the surface 3B than the surface 3A of the tool.

Fig. 5 shows a curve 3D which represents the profile of a possible concavity formed on the face of the tool corresponding to that of the smaller (non-hardened) side F2. This recess of annular form, which may have a depth of one or two tenths of a millimeter and which may also be formed on the opposite face, serves to reduce the friction between the tool and the material to be cut.

It should be understood that the drawing shows only an example provided solely as a practical demonstration of the invention, and that this invention can be varied in its forms and arrangements without departure from the scope of the guiding principle of the invention.

CLAIMS

1. A disk-shaped cutting tool comprising a continuous circumferential cutting edge and an axis of rotation, characterized in that said cutting edge is formed by a chamfer defined by two asymmetrical sides, one having a greater extension and the other having a smaller extension, the side with the greater extension being surface hardened.

2. The cutting tool as claimed in claim 1, characterized in that the two sides form a chamfer with an angle in the range from 15° to 30° at the vertex.

3. The cutting tool as claimed in claim 1 or 2, characterized in that said two sides form two angles with a plane orthogonal to the axis of rotation of the tool, the difference between these angles being in the range from 0 to 10° and preferably in the range from 0 to 3°.

4. The cutting tool as claimed in claim 1 or 2 or 3, characterized in that each of the two sides forms an angle in the range from 0 to 15°, and preferably in the range from 0 to 10° and more preferably in the range from 6 to 9°, with respect to a plane orthogonal to the axis of rotation of the tool.

5. The cutting tool as claimed in one or more of the preceding claims, characterized in that said sides have equal inclinations with respect to a plane orthogonal to the axis of rotation of the tool.

6. The cutting tool as claimed in one or more of the preceding claims, characterized in that it is delimited by two flat parallel surfaces.

7. The cutting tool as claimed in claim 6, characterized in that the vertex of said chamfer is positioned, with respect to the axial extension of said tool, in such a way as to divide the thickness into a larger part in the range from 2/3 to 3/4 of the total thickness of the tool, and a smaller part in the range from 1/3 to 1/4 of said thickness.

8. The cutting tool as claimed in one or more of the preceding claims, characterized in that it is made from super-high-speed steel.

9. The cutting tool as claimed in one or more of claims 1 to 7, characterized in that it is made from sintered steel.

10. The cutting tool as claimed in one or more of the preceding claims, characterized in that the hardened surface of said chamfer has a hardening obtained by the deposition of one or more materials selected from the group comprising chromium, titanium nitride, chromium nitride, aluminum nitride, and combinations thereof.

11. The cutting tool as claimed in one or more of the preceding claims, characterized in that it has a practically constant thickness in the range from 2 to 4 mm and preferably from 2.5 to 3.5 mm and even more preferably from 2.8 to 3 mm.

12. The cutting tool as claimed in one or more of the preceding claims, characterized in that an annular recess is formed on at least one of the faces of the tool in the proximity of the corresponding side of the chamfer.

13. The cutting tool as claimed in claim 12, characterized in that said recess is formed on the face of the tool corresponding to the smaller and non-hardened side.

14. A method of sharpening a disk-shaped cutting tool comprising a continuous circumferential cutting edge formed by a chamfer defined by two sides, characterized by: providing said two sides asymmetrical, one having a greater extension and the other having a smaller extension, the side with the greater extension being hardened; and by bringing a sharpening element periodically into contact with the non-hardened defining side of said chamfer.

15. The method as claimed in claim 14, characterized in that said sharpening element is kept rotating by means of an actuator.

16. A cutting machine for cutting rolls of wound-up web material, comprising a rotating disk-shaped tool with a continuous circumferential cutting edge and a sharpening device for said tool, characterized in that the cutting edge of the tool is formed by a chamfer defined by two asymmetrical sides, one having a greater extension and the

other having a smaller extension, the side with the greater extension being surface hardened.

17. The cutting machine as claimed in claim 16, characterized in that said sharpening device has at least one grinding wheel acting only on the non-hardened side of said tool.

18. The cutting machine as claimed in claim 17, characterized in that said grinding wheel is motorized.

19. The cutting machine as claimed in one or more of claims 16 to 18, characterized in that the sides of the tool form angles whose difference is in the range from 0 to 10° and preferably in the range from 0 to 3° with a plane orthogonal to the axis of rotation of the tool.

20. The cutting machine as claimed in one or more of claims 16 to 19, characterized in that each side has an inclination in the range from 0 to 15°, and preferably in the range from 0 to 10° and more preferably in the range from 6 to 9°, with respect to a plane orthogonal to the axis of rotation of the tool.

21. The cutting machine as claimed in one or more of claims 16 to 20, characterized in that the cutting edge is delimited by two flat parallel surfaces.

22. The cutting machine as claimed in claim 21, characterized in that the vertex of said chamfer is positioned, with respect to the axial extension of said tool, in such a way as to divide the thickness into a larger part in the range from 2/3 to 3/4 of the total thickness of the tool, and a smaller part in the range from 1/3 to 1/4 of said thickness.

23. The cutting machine as claimed in one or more of claims 16 to 22, characterized in that said tool has a practically constant thickness in the range from 2 to 4 mm and preferably from 2.8 to 3 mm.

24. The cutting machine as claimed in one or more of claims 16 to 23, characterized in that said tool has an annular recess on at least one of the two faces.

FIG. 1

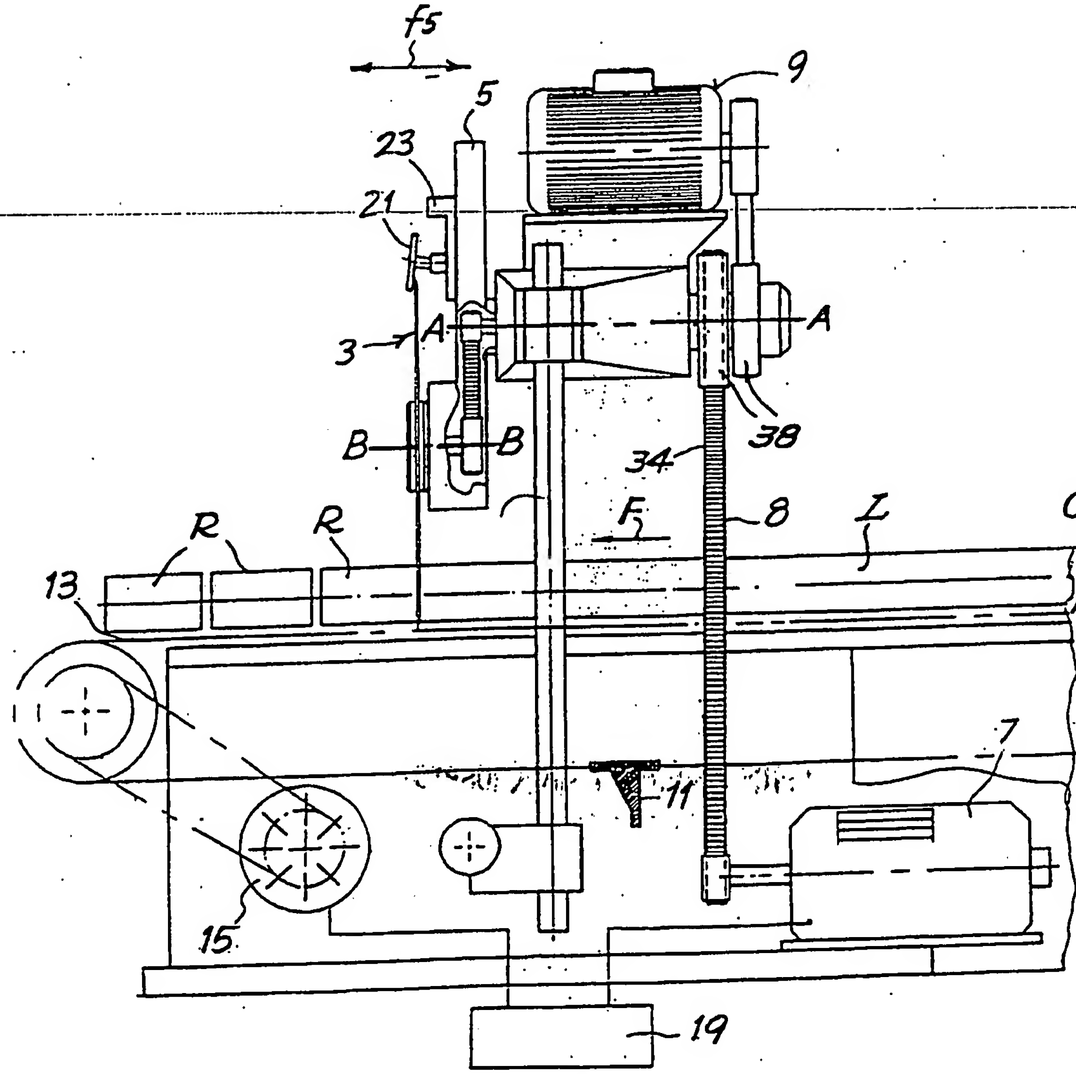

FIG. 3

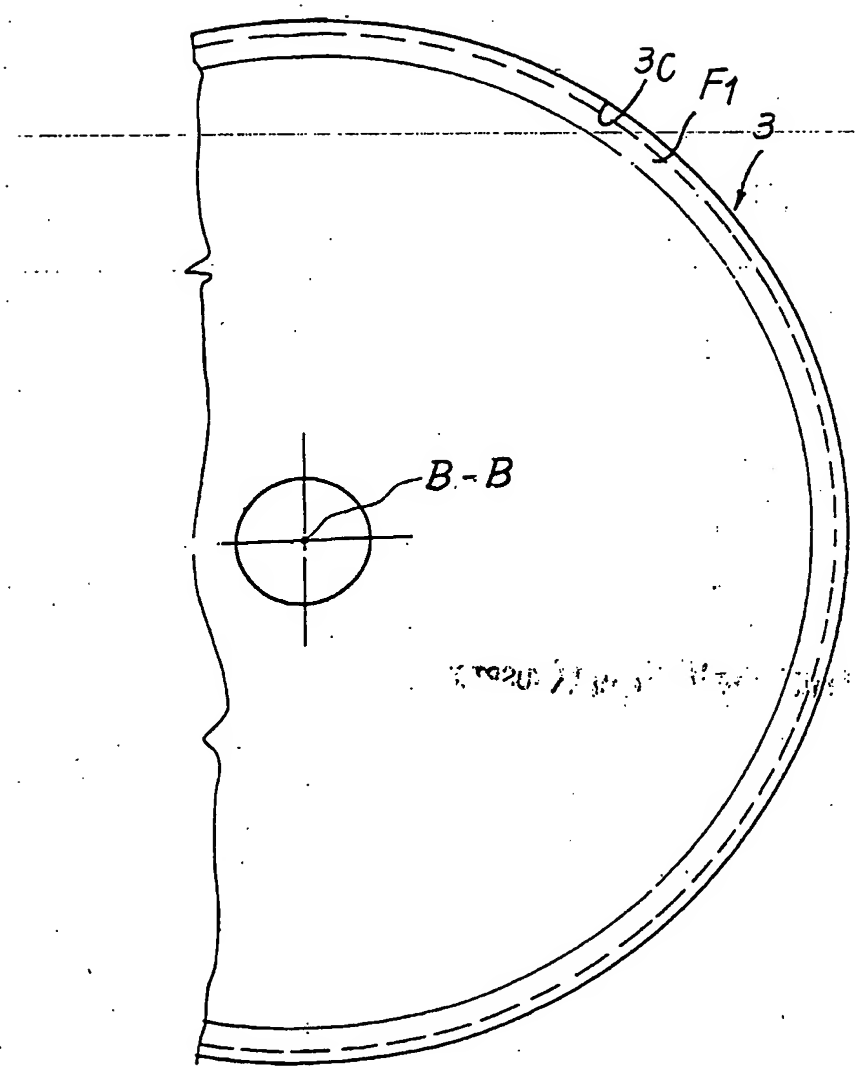

FIG. 2

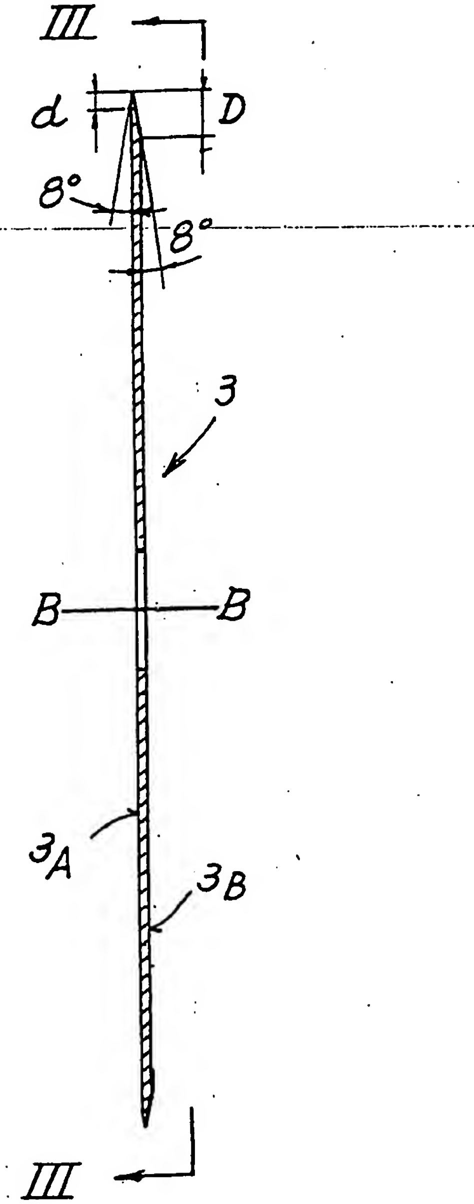

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FIG.4

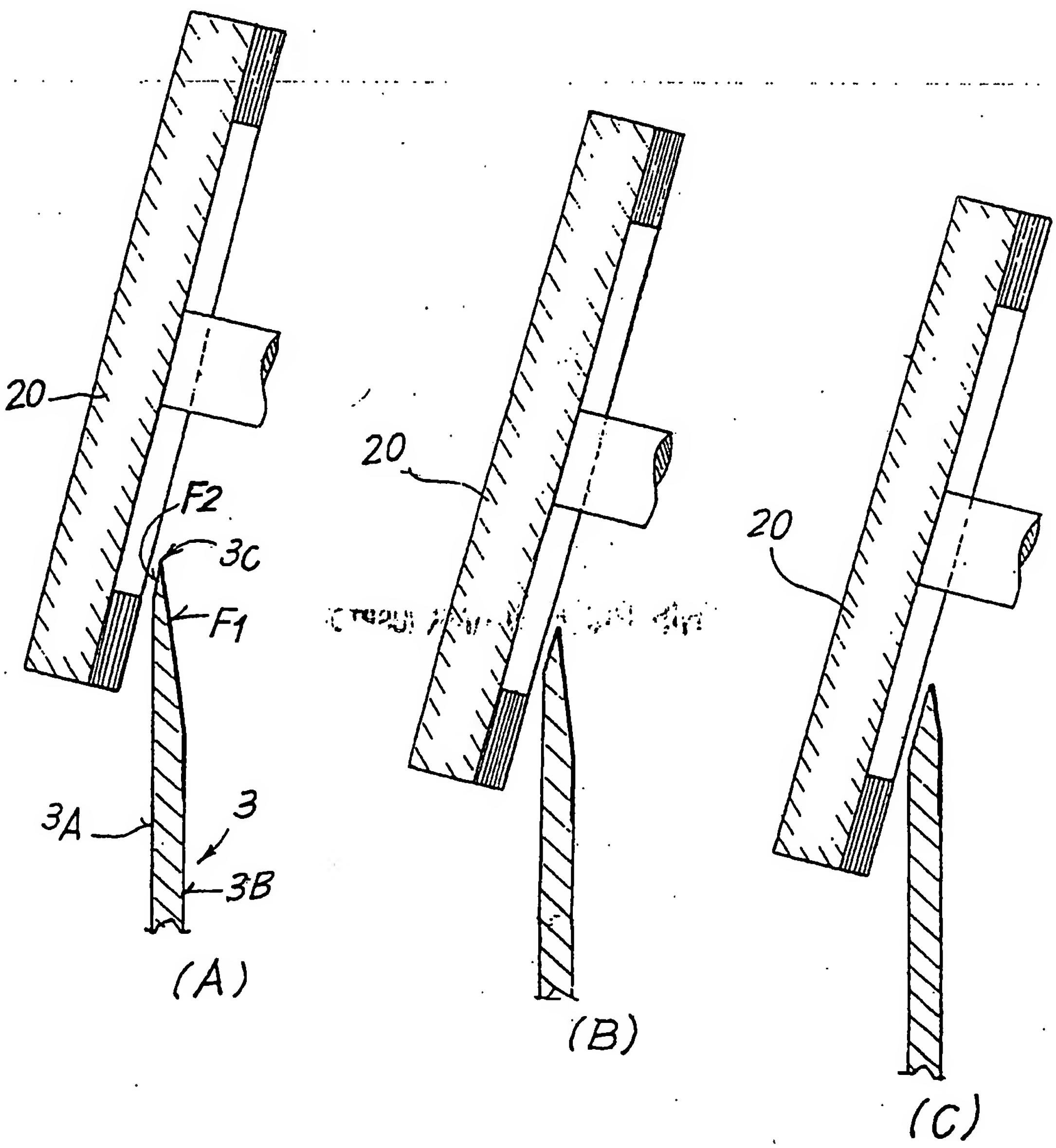
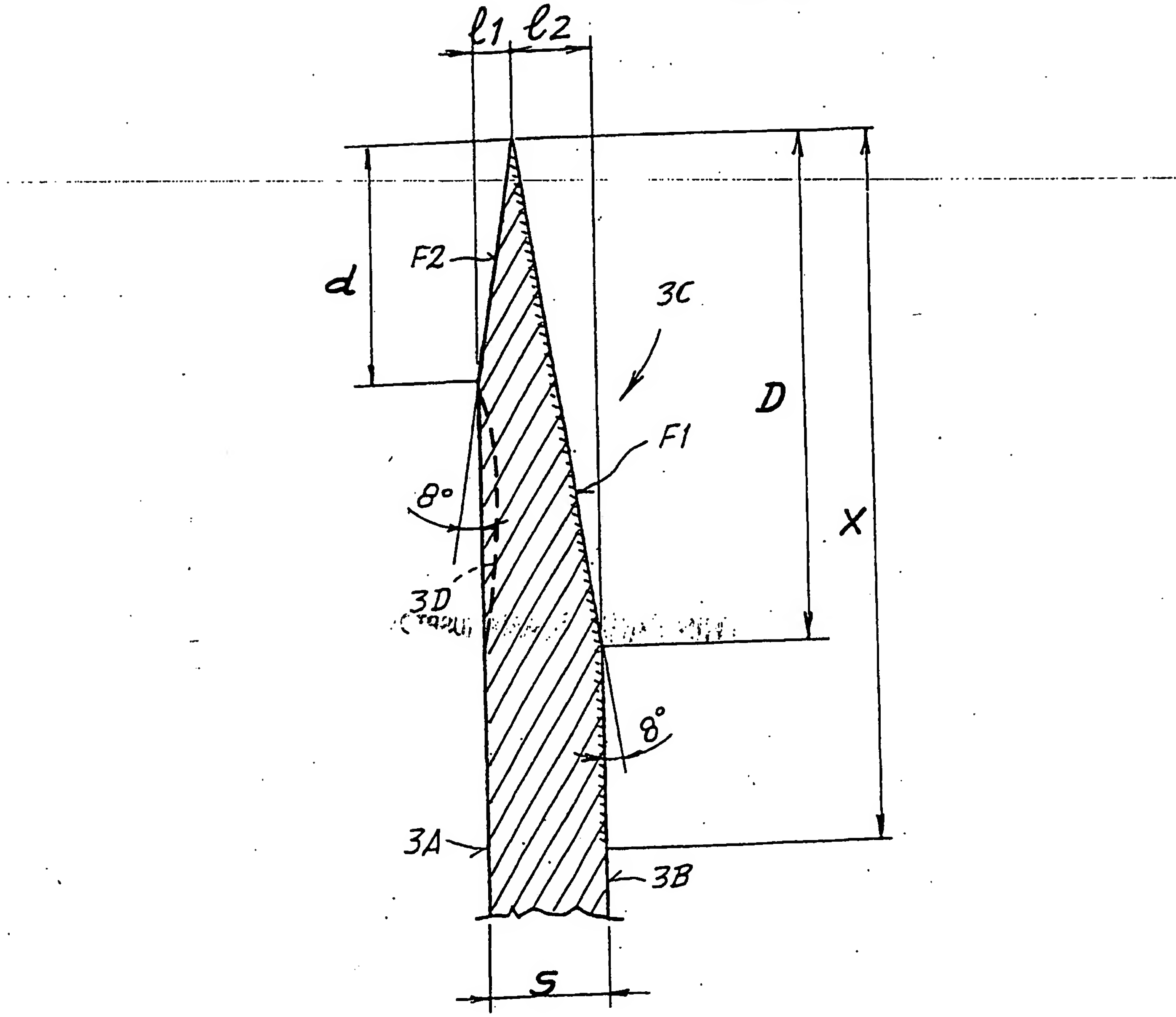


FIG.5



INTERNATIONAL SEARCH REPORT

International Application No
PCT/IT 99/00320

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B26D1/00 B26D7/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B26D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	DE 297 10 489 U (RASSPE SOEHNE P) 15 October 1998 (1998-10-15) page 4, line 15 -page 5, line 29; figures	1,12
X	DE 42 00 147 A (JAGENBERG AG) 8 July 1993 (1993-07-08) abstract	1,12
X	DE 44 31 382 A (MWS SCHNEIDWERKZEUGE GMBH) 7 March 1996 (1996-03-07) claim 1; figures	1,12
Y	DE 296 07 305 U (WABAEMA GMBH) 4 July 1996 (1996-07-04) page 1, line 22 page 4, line 15 - line 30; figure 2 -/--	1,12

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
21 January 2000	28/01/2000

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1

INTERNATIONAL SEARCH REPORT

International Application No
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